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Motion Sickness Mitigation Using VR/AR Devices

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Abstract

Motion sickness is a common problem experienced by individuals travelling in enclosed vehicles. Such condition occurs in a ship/boat encountering rough waves (sea-sickness), or a land vehicle going through a rugged terrain, in aircrafts, etc. It happens when there is a mismatch between the motion perceived by the human vestibular system in the ear and the motion seen by the eyes. The interior of a ship/motor vehicle is visually observed by person to be stationary, while the vestibular system (which is a fluid filled structure inside the ear) still perceives the motion of the ship/vehicle. The present disclosure aims to mitigate motion sickness using Virtual Reality/Augmented Reality (VR/AR).

Background

Motion sickness primarily arises from three types of conditions –

- Motion seen - not felt
- Motion felt - not seen
- Motion seen and felt but do not correspond to each other

Motion seen – not felt is the type of motion sickness that commonly occurs in a person while watching content with a high rate of movement (such as a roller coaster simulation ride or playing a game) using a VR device, commonly known as VR sickness.

Motion felt – not seen corresponds to motion sickness experienced while travelling in ships (sea-sickness) specially on a lower deck with a rough sea, where there is no way to see the motion of the ship, or cars (car-sickness), where such sickness arises when an individual is constantly focusing of a smartphone or a magazine and hence does not get visual of the car's motion with respect to (w.r.t.) the surroundings, or aircraft (air-sickness) caused when the uniform looking blue sky and the clouds fail to provide any substantial visual perception of the roll-pitch-yaw motion of the aircraft.

Motion seen and felt but do not correspond is experienced in a rotating frame of reference such as in a centrifuge and simulated gravity environments that use centrifugal action to mimic gravity. Coriolis forces generate a sense of motion though no motion is visually observed.

With the advancement of VR/AR technology there has been considerable research that target motion sickness caused by VR use. However, no substantial work has been done to mitigate an already occurring motion sickness condition using VR/AR technology. Hence, there exists a need and definite possibility to address motion sickness by harnessing the capabilities of VR/ AR.

Problem

The disclosure sources from a commonly experienced motion-related problem known as 'motion sickness'. The addressed problem may include multiple scenarios, where an individual is facing motion sickness due to sea-sickness, sickness felt in a boat, sickness felt in land motor vehicle, aircraft and the like.

Solution

The solution involves using an VR/AR wearable device that continuously produces visual stimuli that let the user have a perception of a true horizon reference in the Field of Vision (FOV). The end objective of using such a device is to match the visual stimuli with the perceived vestibular senses stimuli during motion.

Description of embodiments

<u>Embodiment 1 - VR implementation with complete moving image of surroundings:</u>

The first mode of carrying out the invention is through a VR device. The VR device may be wearable glasses, a headset, a helmet, or the like.

The user's surroundings are captured by a multidirectional camera for a 3-D view. Orientation sensors sense orientation and actual motion w.r.t. the surrounding environment. A processor combines the camera feed with the data received from the orientation sensors to recreate and replace the actual scene to project on the device's screen - a recreated 3-D spatial scene that moves in a direction opposite to the motion/orientation change perceived by the orientation sensors. For example, if a person is sitting stationary inside his room in a ship, he/she is in the same frame of reference as the room interiors. If the ship moves, the room also moves the same way and so does the person. So, no motion is visually perceivable. Had the person been standing on the ship deck, he/she would have observed the horizon moving in correspondence with the ship's movement. If the ship makes a rolling motion from left to right direction, the person witnesses the horizon moving from right to left. This right to left movement visual stimulus is artificially created in the wearer's VR device by showing the room's interior in the FOV of the user to be moving in a right to left direction. Thus, the user's vestibular senses are corroborated by the visual stimuli, mitigating any stimuli mismatch. As a result, the motion sickness can be suppressed.

The system architecture (as shown in Figure 1) comprises of a user wearable VR device. The VR device is equipped with –

- one or more cameras,
- orientation sensors,
    - a gyroscopic sensor,
    - a tri-axial accelerometer,
    - a magnetometer,
- a central processor,
- a Graphics Processing Unit (GPU), and
- a VR screen.

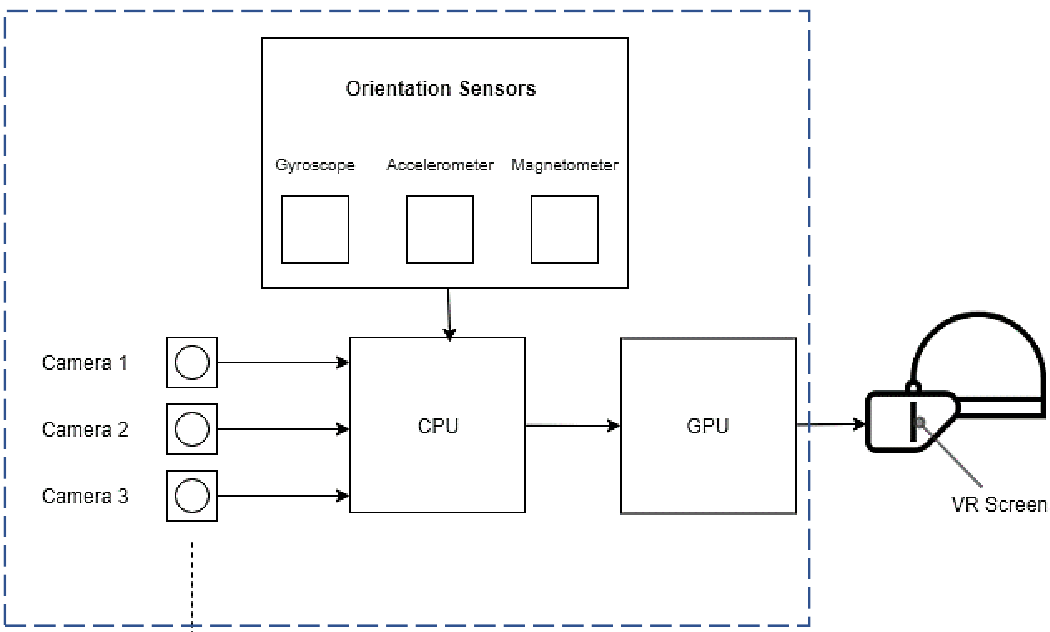


Figure 1 – System architecture of a user wearable VR device

In a preferred embodiment, the system has multiple camera sensors to capture a video of the surrounding of the individual such as the 3-D view of the interiors of the room. The gyroscopic sensor, tri-axial accelerometer and magnetometer comprise the orientation sensor suite of the system. The data from these three sensors are combined to calculate the real time spatial orientation of the user. In an alternate embodiment, the spatial orientation data may be further enhanced by tracking objects in the video data to factor in the user's own head motion. The final spatial orientation data and the video input from the cameras are sent to the CPU. The CPU combines the video data output by the cameras and the determined real time data of the spatial orientation of the user to generate an output that is sent to the GPU for rendering. The GPU finally produces the simulated video feed of the surroundings to be displayed on the screen of the VR device. In the current embodiment, the VR device includes the system architecture (from Figure 1) integrated into the VR device. Alternatively, people skilled in the art will understand that one or more of the components from the system architecture can also be a part of a smartphone that can be coupled to the VR device. In such a scenario, the display screen of the smartphone will display the simulated image/video of the surrounding.

Figure 1.1 depicts a scene as visible to a user (highlighted by a green box) when the user is sitting in the interiors of a ship and the ship is in equilibrium state (at rest or constant velocity linear motion). When the ship makes a rolling motion in clockwise direction (as can be seen in Figure 1.2), the VR device makes a corresponding counter-clockwise movement of the image being captured by the cameras to give a realistic visual stimulus of the motion of the ship. As seen in Figure 1.1, the Christmas tree is not visible to the person. As the ship rolls in clockwise direction, as seen in Figure 1.2, the image is given an opposite counter-clockwise rolling motion, and as a result the lower edge of the Christmas tree now becomes visible. Similarly, Figure 1.3 represents the visual on the VR screen when there is a counter-clockwise rolling motion of the ship.

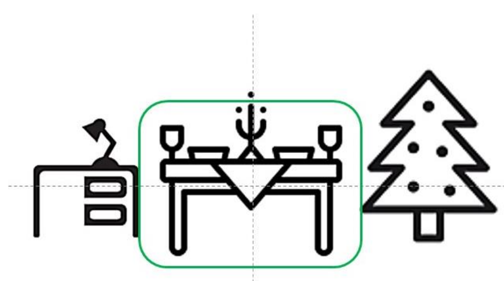


Figure 1.1: Depicts equilibrium view. FOV on VR screen showed in green box

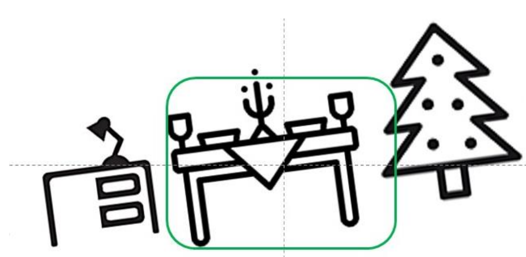


Figure 1.2: View in the green box represents view when individual exhibits a clockwise rolling motion

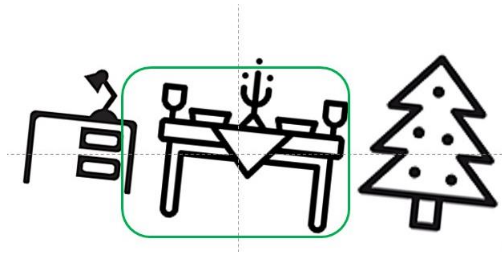
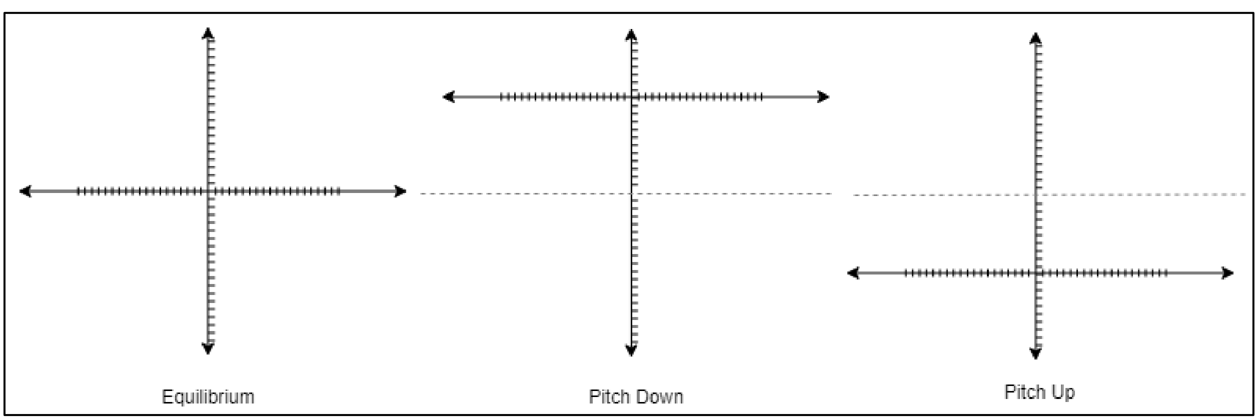
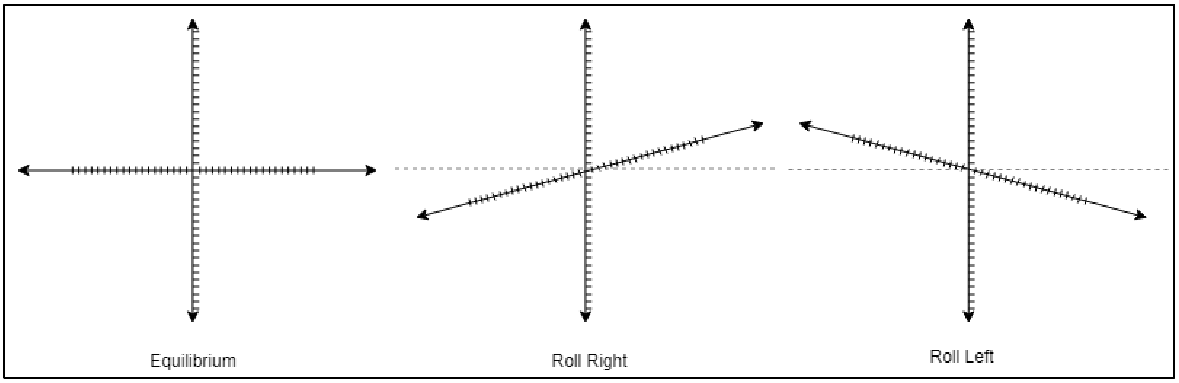


Figure 1.3: View in the green box represents view when individual exhibits a counter-clockwise rolling motion

Embodiment 2 - AR implementation with horizon markers:

The second mode of carrying out this invention is through AR or mixed reality. This approach is based on a similar concept as described for VR, as described earlier, but differs minutely in implementation. In AR, the user can see the actual surrounding, through a transparent element and the intended data is projected on the transparent element as overlay elements. Primarily six variations of motion are possible - three translational motion along the X, Y and Z axes and three rotational motions known as roll, pitch and yaw. Figure 2 depicts the variations of motion. The approach constitutes displaying a calibrated horizon reference. The horizon reference is depicted as a graduated reference cartesian axes. The horizontal axis depicts a virtual horizon line. The horizontal line moves up along the vertical axis to depict a pitch down and similarly a pitch up is depicted by the horizontal axis moving down along the vertical axis. Rolling motion towards right is depicted by a counter-clockwise tilting of the horizontal axis and clockwise tilting depicts roll towards left. Yaw motion is indicated by a lateral shifting of the vertical axis along the horizontal axis. A yaw to the right is depicted by the vertical axis relatively moving towards left of the horizontal axis and vice versa.





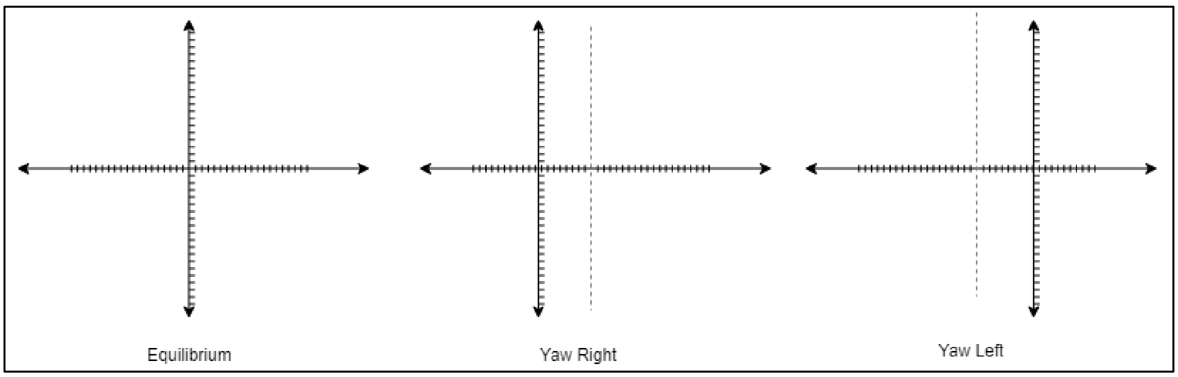
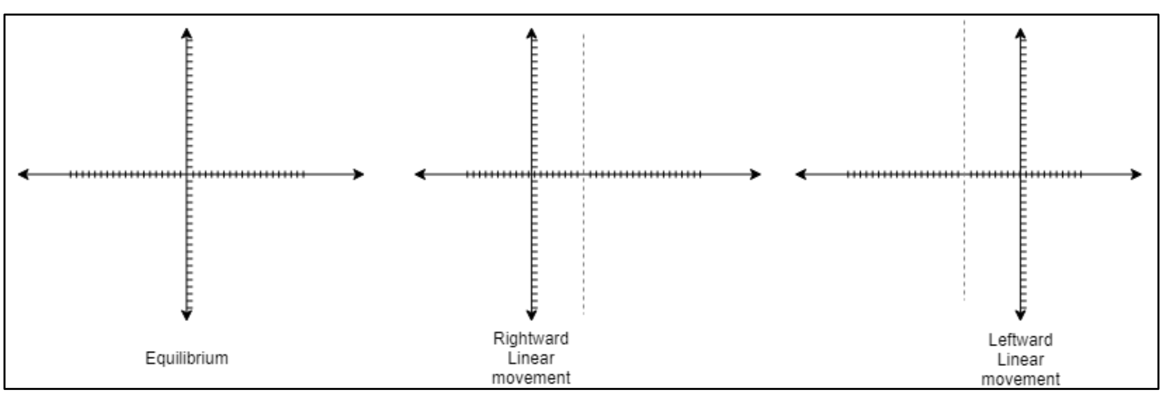


Figure 2 – AR – Pitch, Roll and Yaw movements (The horizontal graduated axis depicts a virtual horizon)

For depicting rectilinear motion, a similar cartesian axis system may be implemented. Figure 3 highlights the rectilinear motion. A movement to the right is depicted by a corresponding leftward shifting of the vertical axis that presents a visual perception of the rightward movement. Similarly, a leftward movement is presented as a rightward shift of the vertical axis. Likewise, an upward movement is visually conveyed as a downward shift of the horizontal axis and vice-versa. A forward movement conveyed by partly enlarging the projected image of the axis system giving a perception of zoom-in that is perceived as a forward movement. Similarly, a zoom-out would give a rearward movement perception.



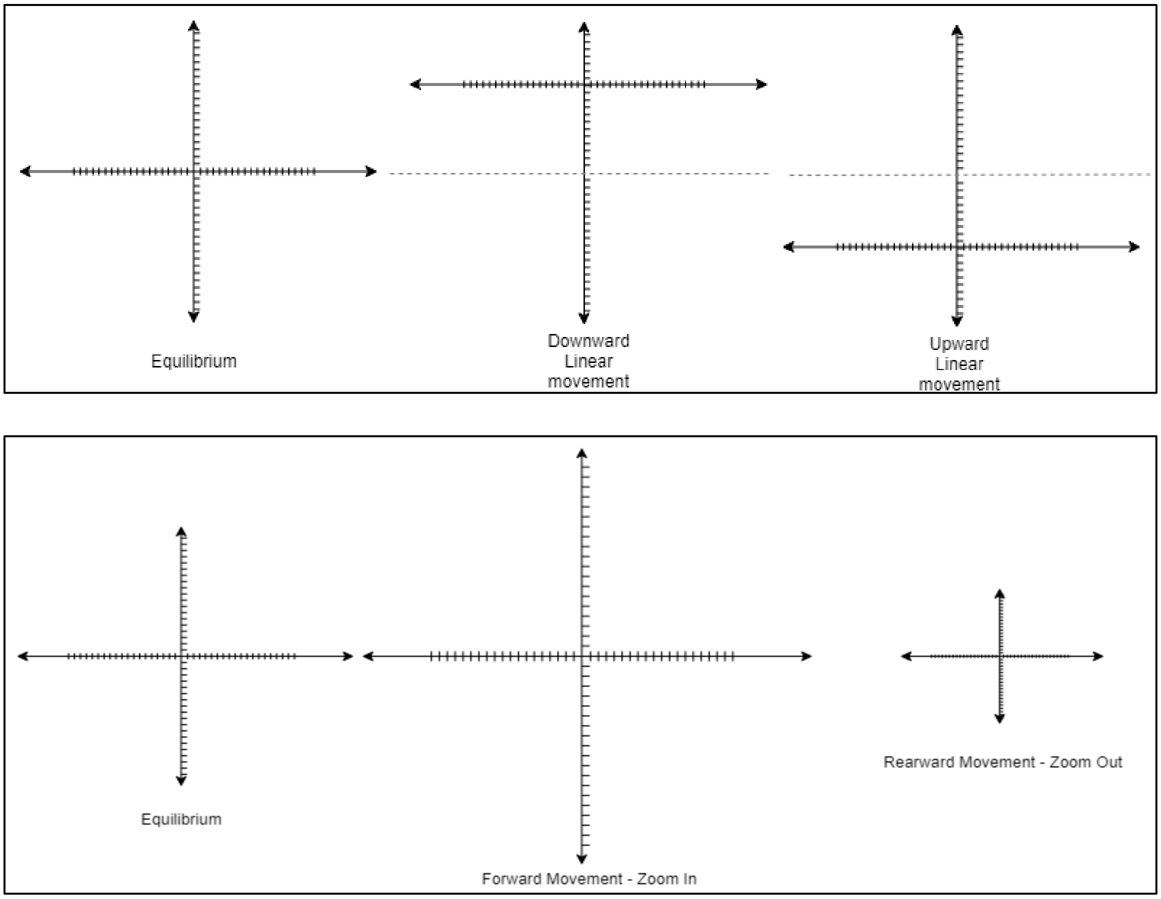


Figure 3 – AR – Right-Left, Up down and Front-Rear movements

In an alternate embodiment, the rectilinear motion may also be represented as the image of an object (can be any suitable object) in a cartesian axes system. Movement to the right and left are denoted by the left and right motion of the object image, respectively, w.r.t. the vertical axis. Up and down movement is denoted by moving the object image down and up respectively. Forward and rearward motion is conveyed by a zoom in and zoom out effect of the object image.

Either the shifting-axis system or an object image option may be implemented for depicting rectilinear motion. Alternatively, the user may customize the same and choose from the above two options using a connected smart device (wired or wireless). The smart device can be a smartphone, tablet, a laptop, or the like that runs a requisite software to implement the customization.

The system architecture (as shown in Figure 4) involves a headgear or an eyewear AR device or any such similar device. The AR device comprises of orientation sensors that include a gyroscopic sensor, a tri-axial accelerometer, a magnetometer. The AR device also includes a central processor (CPU), a graphics processing unit (GPU) and a see-through display screen.

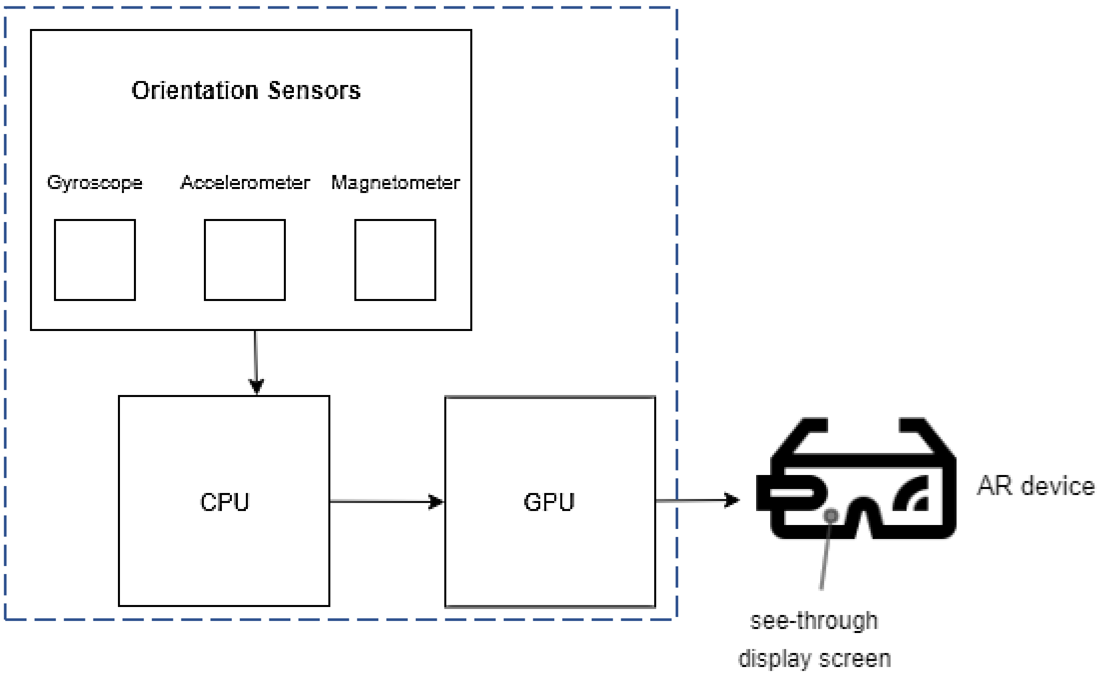


Figure 4 – System architecture of a user wearable VR device

In an embodiment, the processor collects orientation data from the orientation sensors. The processed data is output to the GPU for rendering and is then projected on the see-through display screen in the user's FOV. The displayed image produces visual stimuli that makes the user aware of his/her actual motion, which is otherwise not visually observed due to lack of visual cues.

In one embodiment, the projected image may occupy a central position in the user's FOV for a direct and more perceivable visual perception conveyed by the image. Alternatively, the projected image may also occupy a peripheral position in the user's FOV to have minimal obstruction in the vision. In yet another embodiment, the user may be allowed to customize the position of the projected image as per his/her preference using a connected smart device (wired or wireless). The smart device can be a smartphone, tablet, a laptop, or the like that runs a requisite software to implement the customization.

Conclusion

The fast-paced advancement in VR and AR technologies are set to revolutionize the way we look at the world around us. The implementation can be as fantastic as making a video game feel like real life and can be as basic as addressing a seemingly simple, yet complex long-unsolved problem of motion-sickness. As of now, trends indicate that AR/VR systems will have umpteen application possibilities that will enhance common people's lives in umpteen number of ways.